

## EARLY RIVER AND HARBOR WORKS

### Navigation Above Tide Water

Navigation of the Delaware River above tide water was practiced in pre-Columbian times by native tribes, inhabitants of the region, but there is no evidence that the Indian navigators attempted works intended to modify or exploit the stream's pristine flow characteristics; however, works of this order were undertaken soon after the arrival of commerce-oriented European settlers. Necessarily, regulatory legislation enacted by states whose common boundaries the river defined soon followed.

A Pennsylvania law enacted March 9, 1771 declared:

*"When the improvement of the navigation of rivers is of great benefit to commerce, and whereas many persons have subscribed large sums of money for this purpose; . . . the Delaware and Lehigh Rivers shall be common highways for the purpose of Navigation."*

With this act, twenty-six commissioners were appointed to receive subscriptions and to improve the navigation of the Delaware.<sup>1</sup>

The State of New Jersey legalized common use of the Delaware by an enactment of May 27, 1783:

*" . . . The River Delaware, from the northwest corner of New Jersey to the place upon the said River where the circular boundary of Delaware toucheth upon the same, is, and shall continue to be and remain, a common highway, free and open for the use of both New Jersey and Pennsylvania."*

Specific laws came along to meet changing demands upon the river's resources. Lumbering was first and of great importance to the improvement of the channel. The transit of

log rafts through numerous falls and rifts was fraught with danger. Twenty-four of the more terrifying obstacles between Easton and Trenton were listed in a Philadelphia publication of 1830 as requiring improvement. For many years prior to this, raftsmen had taken their chances.

"In the Delaware River<sup>2</sup> there are no precipitous falls" stated a navigation survey of 1827; small consolation for boatmen who daily coped with hazards as legendary as Foul Rift, 12 miles above Easton; Wells Falls, a 4,780-foot obstacle course starting a mile below New Hope; or the famed Scudder's Falls, where wing dams were first built in 1819 by State of Pennsylvania Commissioners. The treacherous Trenton Falls, with a fall of nine feet eight inches over a length of 3,500 feet, ended the downstream course of water hazards at tidewater.

Log rafting on the Delaware achieved its greatest intensity between 1835 and 1850. The forests along the banks receded year by year as lumbermen worked virgin stands of pine and oak; then hemlock, ash and maple. Eventually, the scarcity of timberlands with reasonable access to the river made log rafting unprofitable. Admittedly on the decline, the production of sawed lumber was still considerable in 1873, as reports on 38 mills situated at 23 locations between Easton and Morrisville<sup>3</sup> indicate. These mills, many powered by water from the river, produced 113,700,000 board feet of lumber from logs rafted down the Delaware that year.

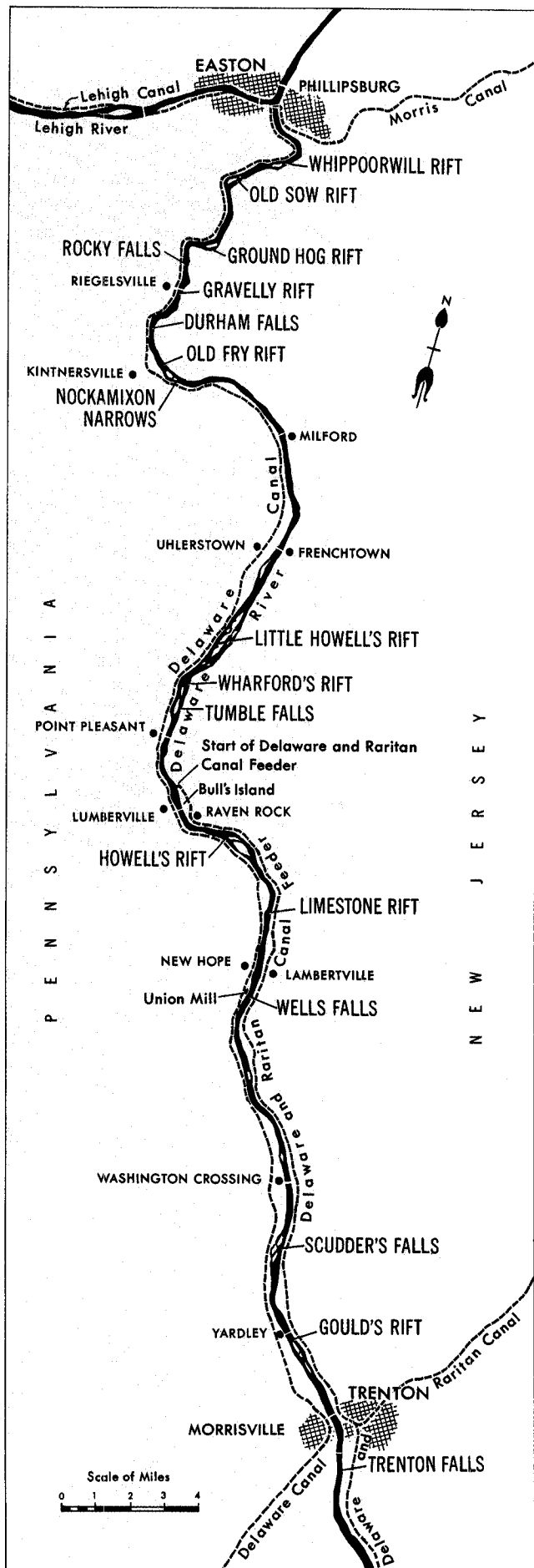
Rafting both preceded and outlasted the arks and Durham boats which served as alternative modes of upriver navigation. The Durham boat, developed initially to transport

*From the Forks at Easton to the fall line at Trenton, 31 rapids were identified by Engineer Merriman and tabulated in his report of 1873. These natural obstacles, commonly known as rifts or falls, were negotiated routinely by ark crews, log raftsmen and Durham boatmen, who were the virtual sole navigators of the upper Delaware.*

the products of the young iron work industry, made its appearance about 1750. This craft is known to have worked the river as far up as the Lackawaxen, 75 miles above Easton and to have served the bog iron furnaces to the south by way of the little rivers of New Jersey. "Arks", rectangular pine boxes 50 to 80 feet long, 16 feet wide with a two-foot draft, came into use with the working of the anthracite mines of northeastern Pennsylvania, beginning about 1810. A portion of this coal traffic should be listed under the heading lumbering, as the arks were strictly one-way craft disassembled at destination and sold as lumber. After the Delaware Division Canal was opened in 1832, arks ceased to descend the Delaware River. Even then, it was becoming difficult to obtain lumber for their construction.

The upriver channel was evidently a wayward, vaguely definable thing. For the most part, raftsmen and boatmen navigated by instinct, legend and a few inconstant landmarks down a course which some called "the natural channel". Rudimentary works of improvement contrived, at relatively meager expense, to maintain the natural channel in such condition as to allow downward passage of rafts, arks and Durham boats at no risk greater than the navigators' lives and cargoes. Upward passage was occasional, strenuous and only for a boat in ballast — a rugged boat like the Durham — round-bottomed and with a virtual zero draft.

The channel was trained by means of wing dams, chute walls and some rock blasting; among many picturesquely named rocks, "Blowed Rock," "Entering Rock" and





“Foam Rock” share the record for frequency. Ten thousand dollars were appropriated in 1817 by the Pennsylvania Legislature for improvement of the river from Trenton to Foul Rift twelve miles above Easton. Most of the money was spent for rock blasting and wing dams at Rocky Falls, seven miles below Easton; at Tumble Falls, above Point Pleasant and halfway between Easton and Trenton; and at Wells Falls, a mile downstream from the New-Hope Lambertville Bridge. All of these works were destroyed and rebuilt several times; many remnants of them are still standing. The principal vested commercial interests along the river, early and late, were the canal companies. Lehigh Navigation Company, running Durham boats and arks down the Lehigh River from White Haven to the Delaware at Easton, was responsible for building and maintaining many of the works which aided navigation. The Delaware and Raritan Canal Company and their lessee, the Pennsylvania Railroad Company, also expended considerable sums on improvements. The New Jersey legislature, in March, 1820 specifically interdicted erection of any structure or device which would create, draw or use water power from the Delaware River. Any proposed construction was to be viewed by three “skillful and respectable freeholders” in each state (New Jersey and Pennsylvania), who would report to the courts by which they had been appointed. The courts could grant permission to build where the commissions found the project offered no menace to navigation. Prior to this, mills along the banks had freely drawn power from the stream; though users rather than consumers of water, they would subsequently operate only by sanction of the courts.

The canals were another matter. Their feeders withdrew water in significant quantities and returned it to the river in such places and amounts as to potentially effect a depletion of levels in the ranges of navigation. There followed, in 1825, 1826, 1828, 1832 and 1833 legislation by both states defining the privileges of water use accorded to the two canal companies, the Lehigh and the Raritan. The feeder for the Delaware and Raritan Canal was built in 1832-34; enabling legislation is found in a Pennsylvania Act dated April 6, 1825 which authorized:

*“The Delaware and Raritan Canal Company to supply the said Canal with water from the (Delaware) River, provided no injury is done to either ascending or descending navigation, but reserves the right to withdraw this privilege if, in consequence, the water of the River is lowered one inch,<sup>4</sup> and also provides that this privilege shall cease whenever the State of New Jersey shall refuse to grant a similar right to Pennsylvania to take the same amount of water.”*

The feeder started at Bull’s Island near a landmark known as Raven Rock, 22 miles above Trenton. It was 60 feet wide, 6 feet deep and navigable. The supply of water continued to be ample until the late 1860’s, without the need of impounding structures. Then, during drought seasons temporary timber dams were placed across the river at Bull’s Island to raise the water level several feet. Permission to erect permanent structures was granted the Delaware and Raritan Canal Company by New Jersey in 1868 and by Pennsylvania in 1872. These structures con-

*The Durham Boat. Workhorse of the Delaware, this sturdy vessel was built in 1750 for the Durham Iron Works in Bucks County, near Riegelsville to transport ore and pig iron through white water to market in Philadelphia. More than 2,000 rivermen ran 300 Durham Boats from Easton to Philadelphia, carrying iron, grain, whiskey and produce downstream, and manufactured goods upstream. Forty to sixty feet long, with an eight foot beam,*

*and a three foot hold, the Durham drew five inches when empty, and thirty inches with a 15 ton load. Downstream, captain and crew used a thirty foot sweep and setting poles to guide the vessel. Upstream, the load was cut to two or three tons and the boat was poled along the bottom of the riverbed. Perhaps its greatest fame is linked to that Christmas night in 1776 when Washington ferried a long-harried army across the Delaware, to take the offensive at Trenton.*

— Washington Crossing Park Commission

sisted of wing dams and a chute and were constructed at a cost of approximately \$30,000.

The Delaware Division Canal was supplied at its summit by waters of the Lehigh River. In this as in other respects it shared common cause with the Lehigh Navigation Company and the paternal ministrations of Josiah White. As Canal Commissioner for Pennsylvania, White took whatever action he deemed essential to make the Delaware Division a viable link in the anthracite navigation system, of which his own Lehigh Canal was a vital component. Between 1829 and 1846 at least four acts of the Pennsylvania Legislature required commissioners to examine the navigation and water power problems of the Wells Falls area. Wing dams and mills had been there ever since 1770. At Union Mill, about a mile below New Hope, water was admitted from the river to the lower sections of the Delaware Division Canal — just completed in 1830. Here was installed the power and lift-wheel arrangement which functioned as a mid-point feeder.

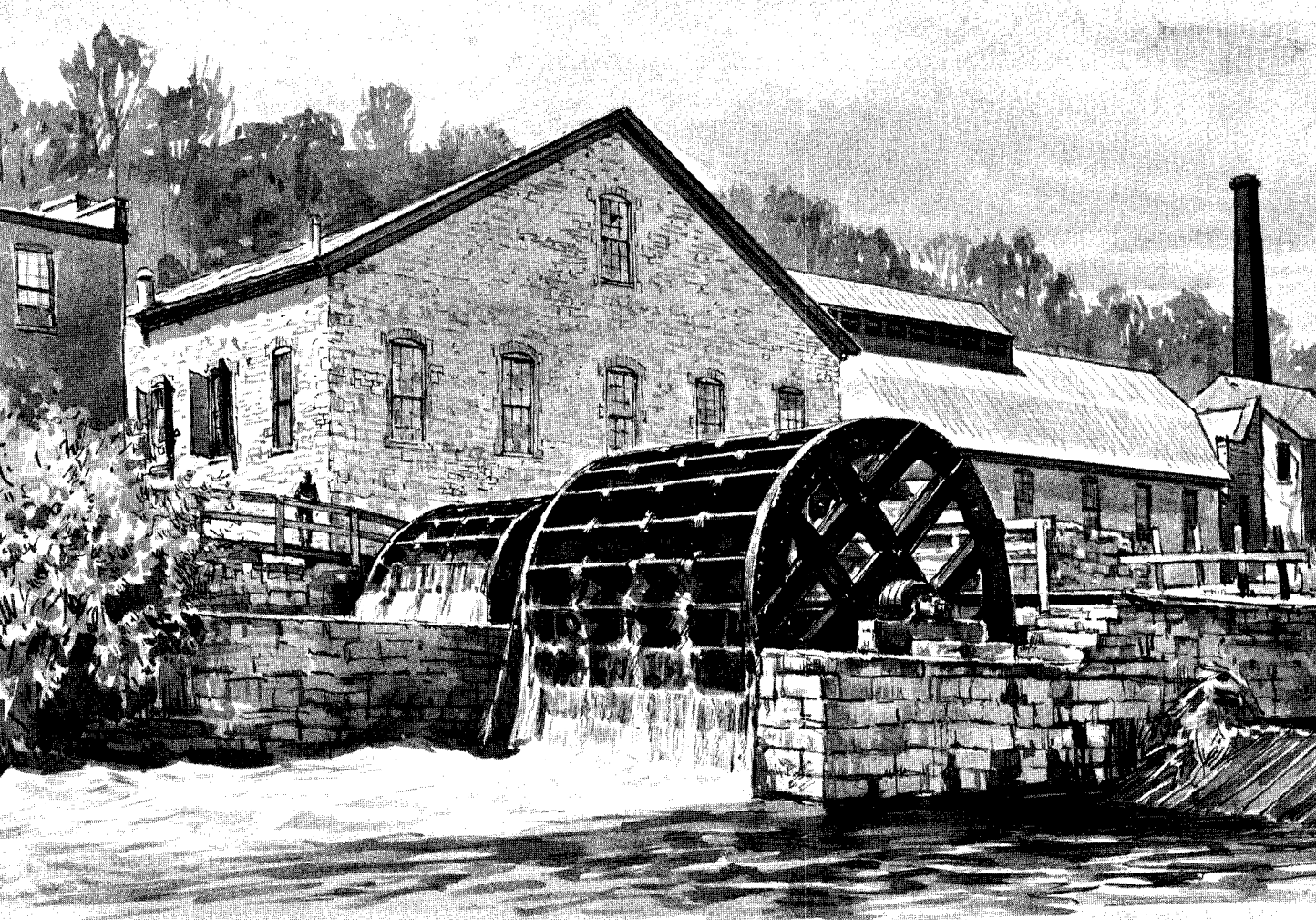
The expense of periodic alteration and annual maintenance of the Wells Falls Dam and feeder was borne by the canal companies, whose interests joined at this point on the river. Here a rope ferry connected the Raritan feeder with the Delaware Canal, both of which had outlet locks to the river 1000 feet upstream from the dam.

Another of Lehigh Navigation Company's projects was the wing dam at Phillipsburg Rift, across the river from Easton, constructed for raft navigation, probably prior to 1820. This structure maintained sufficient depth off the channel to facilitate the crossing

by rope ferry of barges transferring between the Lehigh and Delaware Canals and the Morris Canal. A project was afoot in 1827 to construct a slackwater navigation in the Delaware River from Philadelphia to Easton to Carpenter Point at a cost not to exceed \$12,000 per mile; sufficient depth of channel was to be provided for passage of steamboats. The Pennsylvania Legislature authorized a survey but the project was abandoned with the digging of the Delaware Canal, started in 1827. A small steamboat did ply the river between Lambertville and Easton in the Summer of 1851; the "Major William Barnet", drawing 18 inches loaded, took eight hours for the 36-mile trip. Lambertville was then the end of line of the Belvidere Delaware Railroad. After completion of the railroad in 1857, navigation of the upper Delaware was left to the raftsmen. Only occasionally, in winter with the canal closed, a coal boat made the run on a rare freshet.

Records of appropriations for the benefit of the river by the State of New Jersey appear non-existent prior to 1870. Raftsmen raised \$1,100 by subscription in 1861, which paid for rock blasting and a wing dam at Tumble Falls. Pennsylvania provided \$10,000 in 1866 for more improvements at Tumble, at Wharford's Reef above Tumble and at Wells Falls below Lambertville.

The first Federal examination of the Delaware River above Trenton resulted in a survey report datelined Philadelphia, January 2, 1873, titled "Survey of the Delaware River between Trenton, New Jersey and Easton, Pennsylvania" and submitted by Col. J. D. Kurtz, Philadelphia Engineer Office, for the annual report of the Chief of Engineers, FY



*In 1830 power and lift wheels were installed at Union Mill to take water from the river and feed it into the Delaware Canal. Wells Falls was at this point, one mile below New Hope.*

1873. The report was substantially a record of the river's condition above tidewater with recommendations for improvements, based on a cruise made by M. Merriman<sup>5</sup> and a crew of five in August and September, 1872. Mr. Merriman's detailed examination and analysis estimated an average annual loss to raftsmen of \$17,300. His proposals for elimination of navigational hazards by specific improvements at seven major and five minor sites included, "at Ground Hog--that the Pennsylvania Channel be dredged or scooped with ox-team, using ordinary road scrapers" and requested a total expenditure of \$23,110.54. Cost of the survey was \$2,738.24. A careful search of Rivers and Harbors records has yielded no evidence of action taken on Merriman's proposals. Log-rafting on the Delaware River decreased as railroads extended their lines

throughout the region and timberlands were turned to other uses by an increasing population.

A preliminary examination of Delaware River between Trenton and Port Jervis was authorized by the River and Harbor Act of 1882. The ensuing report found the cost of improvements to be unjustified as benefits would accrue solely to a declining lumber industry. A study authorized in 1915 was concerned with the reach between Trenton and Easton. It concluded unfavorably because of the unwarranted cost; a commercially profitable channel would require canalization of the river at a cost of over \$7,500,000. The Trenton to Easton reach came again under examination subsequent to the R & H act of September 22, 1922. Again, foreseeable benefits seemed insignificant compared to the

probable expense. Going beyond the defined scope of the report, the Philadelphia District Engineer cited an additional 1,400,000 annual tons which might be hauled by extending navigation improvements a few miles above Easton on both the Delaware and Lehigh Rivers, but added: "under no conditions should the upper Delaware improvement be provided prior to the New Jersey Ship Canal" ("The Missing Link", page 87). In all of the above studies hydroelectric power was dismissed as a negligible consideration.

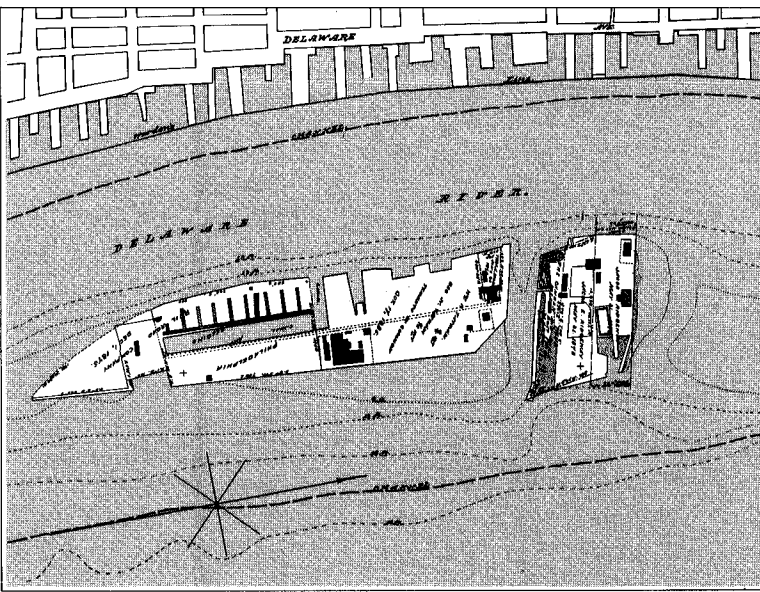
#### Head of Tide to the Sea

A Board of Engineers specially convened in 1885, recommended a plan for permanent improvement of Delaware River and Bay including the preparation of a permanent ship channel from Philadelphia to deep water in Delaware Bay. This channel was to have a minimum width of 600 feet and a depth of 26 feet at mean low water. Prior river improvements were made sporadically under appropriations for specific localities and consisted almost exclusively of dredging. The new plan proposed to obtain a channel by regulating tidal flow with dikes, dredging where necessary, and including provisions for annual maintenance. Estimated cost for the ship channel was \$2,425,000; annual maintenance costs were estimated at one percent of the original cost for dikes and ten percent of the original cost for dredging. From Trenton, natural head of navigation, to the bay the river's course twisted and wound past more than a dozen islands; the channel, 17 to 24 feet deep in its natural state, was impeded by numerous bars, shoals and ledges. The sections offering the most difficulty for projecting and maintaining a proper channel were at

and below Bombay Hook at the river's mouth.<sup>6</sup>

*"In these sections, especially in the lower one, the conditions are most favorable for shoaling. The river is very wide and greatly exposed to the severe actions of storms. The channel occupies a very small part of the width of the bed. During the period of the flood, water from the marine wave pours into the channel, bringing with it material eroded from the shores and bottom of the bay. At the turning of the tide cross currents scour the broad expanse of the river's bed in every direction, and here material brought down in suspension by the outflowing waters of the ebb is most likely to be deposited — the shoals extending throughout the lower section of the river constitute the bar at its mouth, and whether a Channel . . . can be maintained through this bar at reasonable expense can only be determined by actual trial."*<sup>7</sup>

The permanent improvement project of 1885 called for considerable diking and a creditable amount was completed, with good results, in the ensuing 12 years. Dikes were built at Bulkhead Bar, Mifflin Bar and Five-Mile Bar. Much more extensive diking was planned for training the channel above the river's mouth, an area severely affected by the "marine wave," with an extremely soft bottom. Cost estimates of 1885 indicated an economic advantage to building dikes there in preference to a continuous program of dredging. In ten years the balance shifted, due principally to the availability of better and less costly dredging equipment. In 1896, the



*This real estate chart of about 1890 shows Windmill Island (left) and Smith Island in mid-channel before Philadelphia's busy waterfront. After considerable controversy, these sentimental landmarks were removed in 1893.*

dike between Reedy Island and Liston Point was well underway with 6,300 running feet completed and additional 10,500 feet under contract. Originally, the structure was to extend uninterrupted for a length of 26,600 feet. The work was halted by an injunction brought about by citizens of Delaware who claimed that a continuous dike would cut off navigation of Appoquinimink River and Blackbird Creek and affect sanitary conditions between dike and shore. As subsequently completed, the dike provided openings which permitted tidal flow and transit of shipping.

Expenditure of federal funds for improvement of the river from 1836 to 1897 totaled \$2,463,909.77. Of this sum, \$119,479.21 was expended on the section from Trenton to Philadelphia. As of June 30, 1897 the channel was of "navigable width" and seven to eight and one-half feet deep above Philadelphia; from Five-Mile Bar through Bulkhead Bar to deep water the width was 600 feet, the depth varying from 23 to 26 feet.

Within the next year the channel had attained a minimum width of 1000 feet and a 26-foot depth in the Philadelphia Harbor area, and from Philadelphia to Reedy Island had generally reached the minimum controlling dimensions of 600 feet wide by 26 feet deep.

In 1898, after much debate, an old landmark was removed from the Philadelphia waterfront to facilitate the movement of shipping. Windmill and Smith's Islands appear on very early maps as a shoal; accumulated

sediment arrested by self-seeded willows and marsh grass finally reared a mass above the water line. The island became a familiar, sentimental feature of the Philadelphia scene through paintings and engravings of the eighteenth and early nineteenth centuries. Around 1840 a channel was cut through it to provide direct transit of ferry boats plying between Camden and Philadelphia. The two resulting islands became popular resort areas; Smith's especially was a rendezvous for bathers and gourmets. A survey to determine advisability of removing the islands was authorized by Congress in 1882; an appropriation of \$5,000 was approved in 1888 to fund an examination by a board of three engineers as to the effect of the islands upon the flow of commerce.

The resulting polemic between politicians, sentimentalists and shipping interests was won by the latter. A harbor contract calling for the removal of Windmill and Smith's Islands and a portion of Petty's Island (over 20 million cubic yards of material) was awarded to the American Dredging Company in May 1893.

As Major Raymond made his annual report to the Chief of Engineers in 1898 a new channel depth of 30 feet was being studied. This project, according to Major Raymond, "contemplates an improvement much greater than has ever been attempted in any tidal river of a similar character." The Major suggested conservatively that the project might be undertaken with a reasonable probability of success.